Exhibit C
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Limit Orders and Volatility in a Hybrid Market: The Island ECN

Joel Hasbrouck
New York University (NYU) - Department of Finance

Gideon Saar
Cornell University - Samuel Curtis Johnson Graduate School of Management

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Abstract:
This paper presents a cross-sectional empirical investigation of the relations between volatility and various measures of activity on the Island ECN, an Alternative Trading System for US equities that is organized as an electronic limit order book. We find that higher volatility is generally associated with (i) a lower proportion of limit orders in the incoming order flow, (ii) a higher probability of limit order execution, and (iii) shorter expected time to execution. We find weaker evidence that higher volatility is associated with lower depth in the book. In addition, we find that Island's market share for a given firm is positively related to the overall level of Nasdaq trading in the firm, and document substantial use of hidden limit orders (for which the submitter has opted to forgo display of the order). Finally, over one quarter of the limit orders submitted to Island are canceled (unexecuted) within two seconds or less. The extensive use of these 'fleeting' orders is at odds with the view that limit order traders (like dealers) are patient providers of liquidity.

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Contact Information

Joel Hasbrouck
New York University (NYU) - Department of Finance
(email)
44 West 4th Street
MEC Suite 9-190, Mail Code 0268
New York, NY 10012-1126
United States

at the same price. From a market design viewpoint, they are thought to encourage traders to supply liquidity when they might be reluctant to disclose the full size of the amount sought.

Our data report executions of hidden orders, but not submissions or cancellations. Our estimates can only suggest, therefore, a lower limit to the usage of these orders. These are reported in Table 11. Executed hidden orders constitute only about 3% of submitted limit orders (defined as submissions of visible limit orders and executed hidden orders), and about 2% by share amounts. They account, however, for almost 12% of all order executions and executed shares. This suggests a more significant presence.

b. Fleeting orders

We have noted that a large number of orders submitted to Island are canceled almost immediately. We term limit orders canceled within two seconds of their submission "fleeting". Table 11 reports summary statistics. On average in the full sample, fleeting orders constitute 27.7% of all visible orders and 32.5% relative to shares in all visible orders. In the subgroup means, relative usage declines modestly with capitalization, average trades and σ_r. Table 12 presents summary statistics on the pricing of these orders. Fleeting orders are primarily submitted at prices that better Island's pre-existing bid or ask.

There are several possible explanations for the use of fleeting limit orders. One possibility is that Island receives these orders from automated order routing systems, which act as intelligent agents for customer orders. The strategies used by these systems frequently involve successive attempts to achieve execution at different market centers. For example, if Archipelago receives a marketable order at a time when Island's limit order book posts the best prices, Archipelago routes the order (or part of it) to Island for execution. If the order sent to Island fails to execute, say because the Island prices are no

longer available, Archipelago essentially cancels the Island order and submits one to another market center.[19]

Searching for the best prices in the market may take time, and therefore the ability to cancel orders very quickly on Island (say by specifying a very short time-in-force for the order) is very important. Sophisticated systems can also create synthetic order types that take advantage of the ability to submit and cancel orders quickly. For example, Archipelago has a Now Order type that is matched against its book or routed for execution to a select group of market participants that have direct connections to Archipelago and can accept immediate-or-cancel orders. REDIBook has a special Limit Sweep Order that, when submitted to REDIBook, generates multiple orders seeking immediate execution that are routed to ECNs and market makers at multiple prices between the NBBO and the limit price. These examples suggest that many of the limit orders generated by these systems are directed at removing liquidity from the market, rather than supplying it.[20]

Another possible reason for a fleeting limit order is that the submitter wants to fish for hidden orders that better the opposing quote. A buyer, for example, might submit an order priced just short of the ask quote, hoping to trade against any hidden sell orders. Here as well a fleeting limit order represents a liquidity demander, rather than a supplier. Smart order routing systems may also submit limit orders in an attempt to uncover hidden limit orders. The distinction we make here is that such practices may be carried out by a human trader rather than a computer system.

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[19] The function performed by an order routing system is essentially one of brokerage (as opposed to market making). Many of the systems, however, are implemented by the ECNs themselves or by brokers with close ties to ECNs. Archipelago and REDIBook, for example, incorporate order routing functions into their interfaces. These systems are sometimes generically referred to as smart order routing technology (SORT) systems. Both Smart Order Routing Technology and SORT, however, are service marks of MarketXT.

[20] In light of the ambiguity in classifying fleeting limit orders into liquidity demanding or supplying, we repeated the analysis of submission and execution proportions without fleeting limit orders. The results were qualitatively similar to those presented and discussed in Section 6.

The question then arises as to why the buyer's order in the above example needs to be visible, even briefly. A hidden order would accomplish the same thing without revealing the buyer's interest. Our data cannot characterize the extent of such practices. The fact that many of the fleeting orders are visible, though, suggests that finding hidden sellers is not the only motive, and that the brief display serves some purpose. The display might signal tentative buying interest to prospective sellers, without going so far as to provide them with a firm option.

Another potential explanation for fleeting limit orders is a manipulative tactic known as "spoofing". To manipulate, a trader places a visible order in the opposite direction of the trade that is genuinely desired. For example, a seller might post a small buy order priced above the current bid, in hopes of convincing other buyers to match or outbid. If this occurs, the trader can sell into this (higher) price. It is necessary here that the order be visible. The practice resembles "shilling" by an auction seller, but there are some significant differences. In the stock market, the manipulator runs the risk that the spurious bid will be hit by some other seller, increasing the manipulator's long position. On the other hand, the Nasdaq market includes one group of buyers who are compelled to match the manipulator's spurious bid: dealers whose order preferencing arrangements require them to execute the preferenced order flow at the best prevailing price. This might make the manipulative strategy an appealing one. Both the NASD and SEC are conducting investigations and maintaining surveillance, however, against such practices (see Connor (2000)). The possibility of detection and prosecution is significant, and for this reason we doubt that such tactics lie behind the bulk of the fleeting orders.

8. Island's market presence

Island is only one venue in a broader market that comprises other ECNs and traditional dealers. In this section we examine the relative share of Island activity, and firm and investor characteristics to which it is related.

Table 13 presents summary statistics on Island's market share. For the average firm in our sample, Island's market share is roughly 6.2% by trades and 3.5% by volume.